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macLean
2D-510

350A/B

ATTENUATOR SET

OPERATING AND SERVICING MANUAL



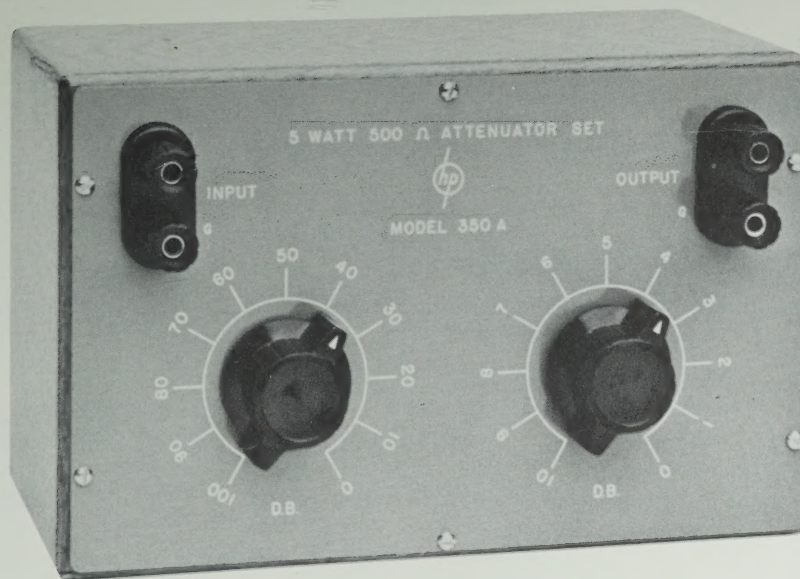
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HEWLETT PACKARD

OPERATING AND SERVICING MANUAL



MODEL 350A/B ATTENUATOR SET SERIAL 1 AND ABOVE



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SECTION I

GENERAL INFORMATION

1-1 DESCRIPTION

The Model 350A/B Attenuator Set provides 110-db attenuation in 1-db steps from dc to 100 kc, and dissipates 5 watts. The Set consists of two bridged-T circuits mounted in a small cabinet. One circuit is a 100-db attenuator adjustable in 10-db steps; the other is a 10-db attenuator adjustable in 1-db

steps. Only precision ($\pm 1/2\%$) resistors are used, which results in a high order of accuracy. Frequency response is flat to 100 kc; response of a typical Set to 200 kc is shown in Figures 2-3 and 2-4. The impedance (input and output) of the 350A is 500 ohms, of the 350B, 600 ohms. Otherwise the Sets are the same.

SPECIFICATIONS

ATTENUATION RANGE:	110 db, in 1-db steps.
	10-db section: 1 -db steps
	100-db section: 10-db steps
ACCURACY, 0 to 100-kc:	10 -db section: Error less than ± 0.125 db at any step
	100-db section: Error less than ± 0.25 db at any step up to 80 db, less than ± 0.5 db on 90-and 100-db steps.
INPUT IMPEDANCE:	Model 350A-500 ohms. Model 350B-600 ohms.
OUTPUT IMPEDANCE:	Model 350A-500 ohms. Model 350B-600 ohms.
MAXIMUM POWER DISSIPATION:	5 watts, continuous duty.
DIMENSIONS:	Cabinet Mount: 8-1/4 in. wide, 5-5/8 in. high, 5-5/16 in. deep.
	Rack Mount: 19 in. wide, 5-1/4 in. high, 3-7/8 in. deep behind panel.
WEIGHT:	Cabinet Mount: Net 3 lbs; shipping 7 lbs.
	Rack Mount: Net 3 lbs; shipping 10 lbs.
ACCESSORIES AVAILABLE:	AC-16A Cable Assembly. RG-58/U 50-ohm coaxial cable terminated at each end with a dual banana plug; over-all length, 44 in.
	AC-16B Cable Assembly. RG-58/U 50-ohm coaxial cable terminated at one end with a dual banana plug, a UG-88/U Type BNC male connector at the other; over-all length, 45 in.

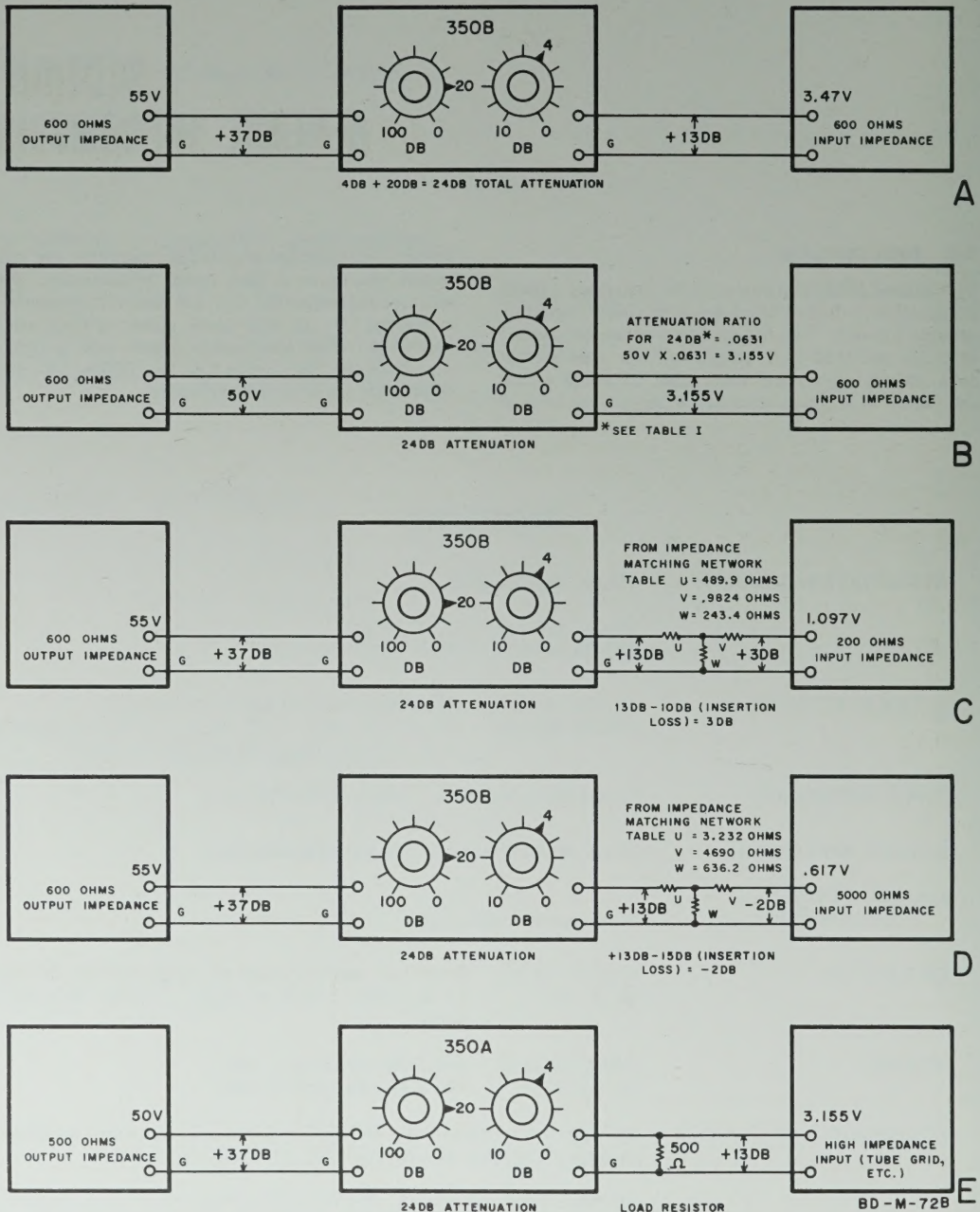


Figure 2-1. Typical Applications Model 350 A/B Attenuator Sets

SECTION II

OPERATING INSTRUCTIONS

2-1 GENERAL

When the 350A/B is working into matching impedances, the amount of attenuation in the circuit is the sum of the control knob settings. Where there is mismatch in the system, see paragraph 2-2 for recommended procedures. Typical setups are shown in Figure 2-1. In Figure 2-1A, the Set is working into matching impedances, the input signal is at +37 db, and the attenuator is set for 24 db. Figures 2-1C, D, and E indicate setups where there is mismatch.

With power applied to the INPUT terminals, the 350A/B will dissipate 5 watts. For the 350A, 5 watts is 50 volts across a 500-ohm line; for the 350B, 5 watts is 55 volts across a 600-ohm line.

CAUTION

The 350A/B can be damaged by applying power to the OUTPUT terminals or by applying more than 5 watts to the INPUT terminals.

When making connections to the 350A/B, use shielded leads, with the shield connected to the ground terminal. If leads are not properly shielded, the setting of the 350A/B controls may not be the true amount of the attenuation, particularly at high frequencies or at high values of attenuation.

To find the amplitude the voltage has at the output of the 350A/B, see Table 2-1. When sources and Set impedances are matched, the output voltage is the input voltage multiplied by the voltage attenuation ratio which corresponds to the number of db the 350A/B is set for. See Figure 2-1B; here the input is 50 volts and the attenuator is set for 24 db.

2-2 IMPEDANCE CONSIDERATIONS

A. Resistance values for impedance-matching networks, together with the insertion loss for each such network, are given in Tables 2-2 and 2-3.

To determine the total attenuation in the measurement system, the loss due to the matching network must be added to the attenuation inserted by the 350A/B. The use of matching networks is indicated in Figures 2-1C and 2-1D.

B. If the impedance of the source is lower than that of the 350A/B input, the mismatch can be compensated for by inserting a resistor in the line to the source. The value of the resistor should be equal to the difference between the attenuator input impedance and the source output impedance.

C. Mismatch between the source impedance and attenuator input impedance will not affect the attenuator output impedance provided not less than 20 db is inserted by the 350A/B.

D. If the input impedance of the equipment under test is high (approximately 20K or over), impedance match can be obtained by shunting the OUTPUT terminals by an impedance-matching resistor (500 ohms for the 350A, 600 ohms for the 350B). Such an arrangement is indicated for a 350A in Figure 2-1E.

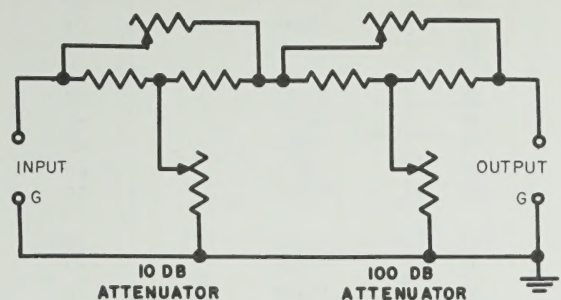


Figure 2-2. Simplified Schematic
Model 350A/B Attenuator Set

2-3 FREQUENCY RESPONSE

Frequency response curves for the 350A are shown in Figure 2-3, for the 350B in Figure 2-4. Inaccu-

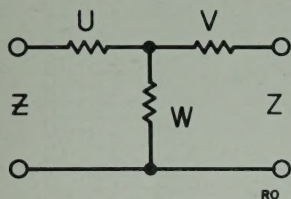
racy because of variation with frequency is negligible at audio frequencies. The small variation at higher frequencies at various settings of the attenuator is shown by the curves.

TABLE 2-1. VOLTAGE ATTENUATION RATIOS

To obtain voltage output of attenuator set when impedances are matched, multiply attenuator input voltage by ratio shown below.

db	Voltage Attenuation Ratio	db	Voltage Attenuation Ratio	db	Voltage Attenuation Ratio
0	1.0000	37	.01413	74	.0001995
1	.8913	38	.012590	75	.0001778
2	.7943	39	.011220	76	.00015850
3	.7079	40	.010000	77	.00014130
4	.6310	41	.008913	78	.00012590
5	.5623	42	.007943	79	.00011220
6	.5012	43	.007079	80	.00010000
7	.4467	44	.006310	81	.00008913
8	.3981	45	.005623	82	.00007943
9	.3548	46	.005012	83	.00007079
10	.3162	47	.004467	84	.00006310
11	.2818	48	.003981	85	.00005623
12	.2512	49	.003548	86	.00005012
13	.2239	50	.003162	87	.00004467
14	.1995	51	.002818	88	.00003981
15	.1778	52	.002512	89	.00003548
16	.1585	53	.002239	90	.00003162
17	.1413	54	.001995	91	.00002818
18	.1259	55	.001778	92	.00002512
19	.1122	56	.001585	93	.00002239
20	.1000	57	.001413	94	.00001995
21	.08913	58	.001259	95	.00001778
22	.07943	59	.001122	96	.00001585
23	.07079	60	.001000	97	.00001413
24	.06310	61	.0008913	98	.00001259
25	.05623	62	.0007943	99	.00001122
26	.05012	63	.0007079	100	.00001000
27	.04467	64	.0006310	101	.000008913
28	.03981	65	.0005623	102	.000007943
29	.03548	66	.0005012	103	.000007079
30	.03162	67	.0004467	104	.000006310
31	.02818	68	.0003981	105	.000005623
32	.02512	69	.0003548	106	.000005012
33	.02239	70	.0003162	107	.000004467
34	.01995	71	.0002818	108	.000003981
35	.01778	72	.0002512	109	.000003548
36	.01585	73	.0002239	110	.000003162

TABLE 2-2. IMPEDANCE-MATCHING NETWORKS FOR 500 OHMS

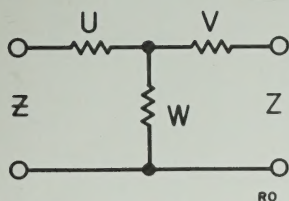


Z = IMPEDANCE AT 350A INPUT OR OUTPUT TERMINALS

Z = IMPEDANCE OF SOURCE OR LOAD

Z (ohms)	Z (ohms)	U (ohms)	V (ohms)	W (ohms)	Insertion Loss
500	50	474.3	1.166	51.40	16 db
500	200	387.3	.8843	256.7	9 db
500	600	13.22	245.2	1148	4 db
500	2000	31.3	1733	536.2	12 db
500	5000	11.66	4743	514.1	16 db

TABLE 2-3. IMPEDANCE-MATCHING NETWORKS FOR 600 OHMS



Z = IMPEDANCE AT 350B INPUT OR OUTPUT TERMINALS

Z = IMPEDANCE OF SOURCE OR LOAD

Z (ohms)	Z (ohms)	U (ohms)	V (ohms)	W (ohms)	Insertion Loss
600	50	574.5	2.111	49.92	17 db
600	200	489.9	.9824	243.4	10 db
600	500	245.2	13.22	1148	4 db
600	2000	33.06	1674	670.8	11 db
600	5000	3.232	4690	636.2	15 db

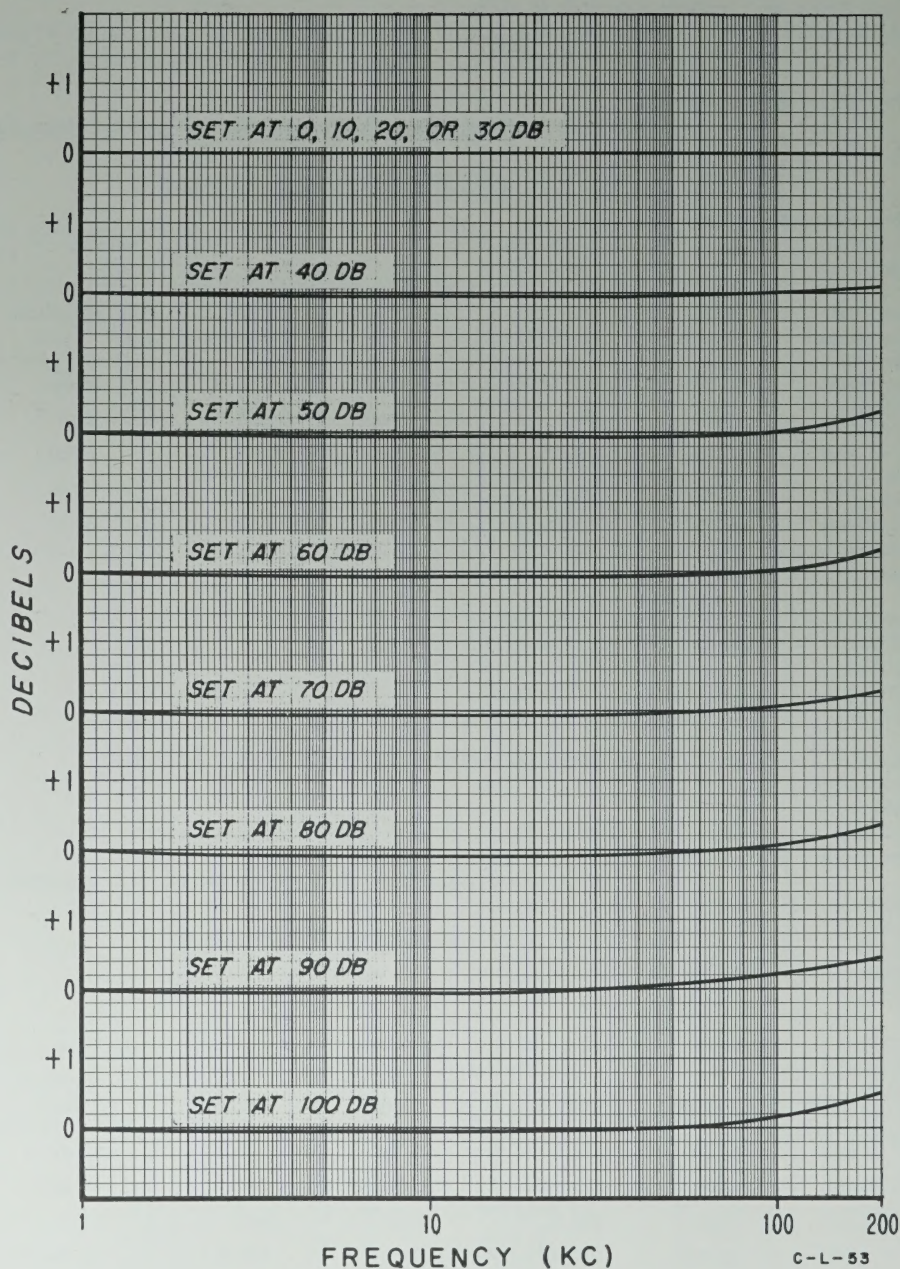


Figure 2-3. Frequency Response of Typical Model 350A Attenuator Set

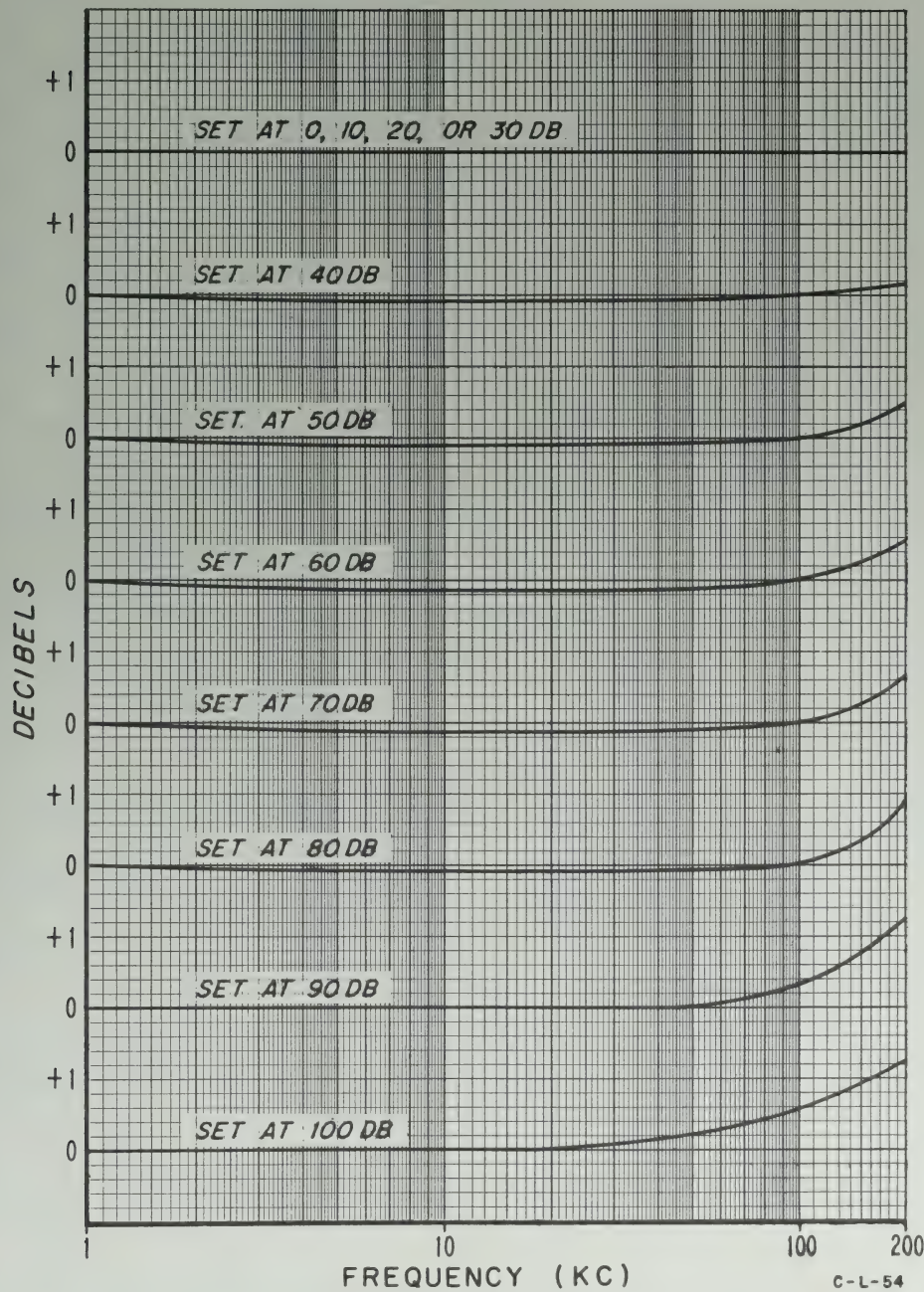
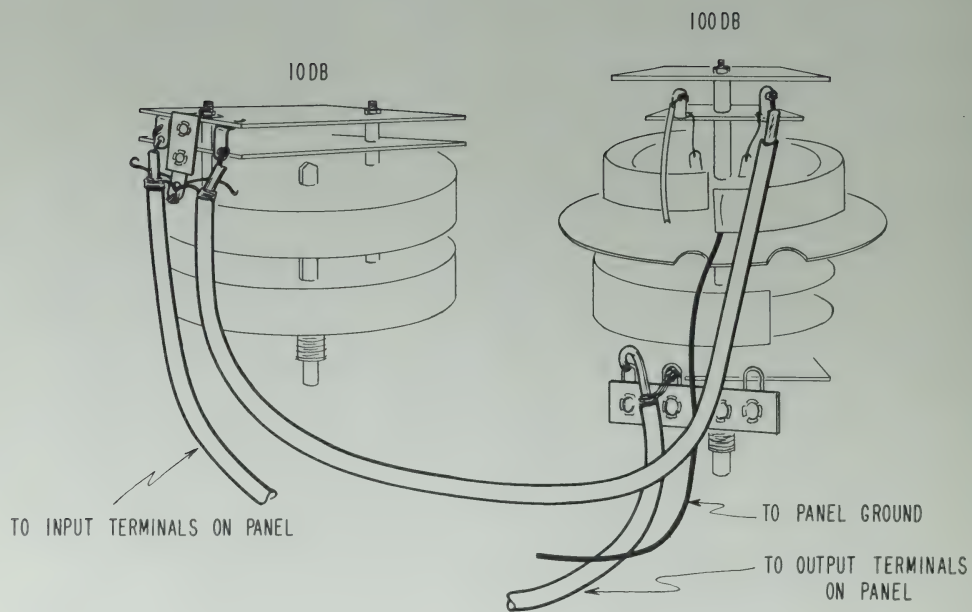


Figure 2-4. Frequency Response of Typical Model 350B Attenuator Set



LD - M - 203B

Figure 3-1. Connections to Attenuator Sections Model 350A/B Attenuator Set

SECTION III MAINTENANCE

3-1 PREVENTIVE

To prevent leakage across the terminals, keep the insulators free of dust.

3-2 LUBRICATION

Once a year apply one drop of light machine oil to the shaft bushings under the knobs.

3-3 REPLACEMENT OF ATTENUATOR SECTIONS

Either the 10-db or 100-db attenuator section may be replaced, or both sections may be replaced as a unit. See the Table of Replaceable Parts (Section IV) for stock numbers.

To reach the attenuator sections, remove the six #4 wood screws which hold the panel to the cabinet, and lift off the panel. The attenuators are on the under side of the panel, in two metal containers; the larger container houses the 100-db section.

To replace the 100-db attenuator section, proceed as follows:

- 1) Remove the black electrical tape from around the container, break the solder seal which fastens the container to the bottom, and lift the container top off the circuitry.
- 2) Carefully note wiring arrangements and connections so that leads can be connected and arranged in the same manner when installing the new attenuator.
- 3) Two cables, the shield of one of the cables, and a ground lead are to be disconnected. These leads are indicated in Figure 3-1.

CAUTION

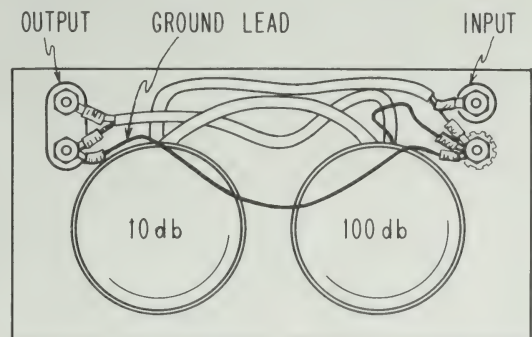
The cable insulation is easily melted; be careful when using a soldering iron.

- 4) Remove the control knob from the attenuator. Use a #8 allen wrench to loosen the two setscrews which hold the knob to the shaft. Remove the hex nut which holds the shaft to the panel.

- 5) Slide the old attenuator out of its mounting, and install the new attenuator.

The 10-db attenuator section is replaced in the same manner. The two cables and their shields which are to be disconnected from the old attenuator and connected to the new are indicated in Figure 3-1.

When both attenuators are replaced as a unit, all soldered connections are made at the factory. Cable connections to the screw-type terminals on the under side of the panel are shown in Figure 3-2. Be sure to reconnect the small black conductor which connects the G terminal on the OUTPUT terminal to chassis ground.



LD-S-256

Figure 3-2. External Connection, Attenuator Sections, Model 350A/B

NOTES


SECTION IV

TABLE OF REPLACEABLE PARTS

NOTE

Readily available standard-components have been used in this instrument, whenever possible. However, special components may be obtained from your local Hewlett-Packard representative or from the factory.

When ordering parts always include:

1.  Stock Number.
2. Complete description of part including circuit reference.
3. Model number and serial number of instrument.
4. If part is not listed give complete description, function, and location of part.

If there are any corrections for the Table of Replaceable Parts they will be listed on an Instruction Manual Change sheet at the front of this manual.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	Ⓢ STOCK NO.	#			
	MODEL 350A and MODEL 350B					
	<u>INPUT</u>					
	Binding Post: black HP*	AC-10C				
	Binding Post: red HP*	AC-10D				
	Insulator: with binding post key HP*	AC-54E				
	Insulator: single HP*	AC-54D				
	<u>OUTPUT</u>					
	Binding Post: black HP*	AC-10C				
	Binding Post: red HP*	AC-10D				
	Insulator: dual, with binding post key HP*	AC-54E				
	Insulator: dual, without binding post key HP*	AC-54A				
	Knob: 100-db and 10-db attenuators HP*	G-74N				
	Attenuator Assembly Model 350A HP*	35A-34				
	Model 350B HP*	35B-34				
	Attenuator Section, 10 db; Model 350A HP*	2AG-34-10				
	Model 350B HP*	26A-34-10				
	Attenuator section, 100 db; Model 350A HP*	2AG-34-100				
	Model 350B HP*	26A-34-100				

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

LIST OF CODE LETTERS USED IN TABLE OF REPLACEABLE PARTS TO DESIGNATE THE MANUFACTURERS

CODE LETTER	MANUFACTURER	ADDRESS	CODE LETTER	MANUFACTURER	ADDRESS
A	Aerovox Corp.	New Bedford, Mass.	AK	Hammerlund Mfg. Co., Inc.	New York 1, N. Y.
B	Allen-Bradley Co.	Milwaukee 4, Wis.	AL	Industrial Condenser Corp.	Chicago 18, Ill.
C	Amperite Co.	New York, N. Y.	AM	Insuline Corp. of America	Manchester, N. H.
D	Arrow, Hart & Hegeman	Hartford, Conn.	AN	Jennings Radio Mfg. Corp.	San Jose, Calif.
E	Bussman Manufacturing Co.	St. Louis, Mo.	AO	E. F. Johnson Co.	Waseca, Minn.
F	Carborundum Co.	Niagara Falls, N. Y.	AP	Lenz Electric Mfg. Co.	Chicago 47, Ill.
G	Centralab	Milwaukee 1, Wis.	AQ	Micro-Switch	Freeport, Ill.
H	Cinch-Jones Mfg. Co.	Chicago 24, Ill.	AR	Mechanical Industries Prod. Co.	Akron 8, Ohio
HP	Hewlett-Packard Co.	Palo Alto, Calif.	AS	Model Eng. & Mfg., Inc.	Huntington, Ind.
I	Clarostat Mfg. Co.	Dover, N. H.	AT	The Muter Co.	Chicago 5, Ill.
J	Cornell Dubilier Elec. Co.	South Plainfield, N. J.	AU	Ohmite Mfg. Co.	Skokie, Ill.
K	Hi-Q Division of Aerovox	Olean, N. Y.	AV	Resistance Products Co.	Harrisburg, Pa.
L	Erie Resistor Corp.	Erie 6, Pa.	AW	Radio Condenser Co.	Camden 3, N. J.
M	Fed. Telephone & Radio Corp.	Clifton, N. J.	AX	Shallcross Manufacturing Co.	Collingdale, Pa.
N	General Electric Co.	Schenectady 5, N. Y.	AY	Solar Manufacturing Co.	Los Angeles 58, Calif.
O	General Electric Supply Corp.	San Francisco, Calif.	AZ	Sealectro Corp.	New Rochelle, N. Y.
P	Girard-Hopkins	Oakland, Calif.	BA	Spencer Thermostat	Attleboro, Mass.
Q	Industrial Products Co.	Danbury, Conn.	BC	Stevens Manufacturing Co.	Mansfield, Ohio
R	International Resistance Co.	Philadelphia 8, Pa.	BD	Torrington Manufacturing Co.	Van Nuys, Calif.
S	Lectrohm Inc.	Chicago 20, Ill.	BE	Vector Electronic Co.	Los Angeles 65, Calif.
T	Littlefuse Inc.	Des Plaines, Ill.	BF	Weston Electrical Inst. Corp.	Newark 5, N. J.
U	Maguire Industries Inc.	Greenwich, Conn.	BG	Advance Electric & Relay Co.	Burbank, Calif.
V	Micamold Radio Corp.	Brooklyn 37, N. Y.	BH	E. I. DuPont	San Francisco, Calif.
W	Oak Manufacturing Co.	Chicago 10, Ill.	BI	Electronics Tube Corp.	Philadelphia 18, Pa.
X	P. R. Mallory Co., Inc.	Indianapolis, Ind.	BJ	Aircraft Radio Corp.	Boonton, N. J.
Y	Radio Corp. of America	Harrison, N. J.	BK	Allied Control Co., Inc.	New York 21, N. Y.
Z	Sangamo Electric Co.	Marion, Ill.	BL	Augat Brothers, Inc.	Attleboro, Mass.
AA	Sarkes Tarzian	Bloomington, Ind.	BM	Carter Radio Division	Chicago, Ill.
BB	Signal Indicator Co.	Brooklyn 37, N. Y.	BN	CBS Hytron Radio & Electric	Danvers, Mass.
CC	Sprague Electric Co.	North Adams, Mass.	BO	Chicago Telephone Supply	Elkhart, Ind.
DD	Stackpole Carbon Co.	St. Marys, Pa.	BP	Henry L. Crowley Co., Inc.	West Orange, N. J.
EE	Sylvania Electric Products Co.	Warren, Pa.	BQ	Curtiss-Wright Corp.	Carlstadt, N. J.
FF	Western Electric Co.	New York 5, N. Y.	BR	Allen B. DuMont Labs	Clifton, N. J.
GG	Wilkor Products, Inc.	Cleveland, Ohio	BS	Excel Transformer Co.	Oakland, Calif.
HH	Amphenol	Chicago 50, Ill.	BT	General Radio Co.	Cambridge 39, Mass.
II	Dial Light Co. of America	Brooklyn 37, N. Y.	BU	Hughes Aircraft Co.	Culver City, Calif.
JJ	Leecraft Manufacturing Co.	New York, N. Y.	BV	International Rectifier Corp.	El Segundo, Calif.
KK	Switchcraft, Inc.	Chicago 22, Ill.	BW	James Knights Co.	Sanwich, Ill.
LL	Gremar Manufacturing Co.	Wakefield, Mass.	BX	Mueller Electric Co.	Cleveland, Ohio
MM	Carad Corp.	Redwood City, Calif.	BY	Precision Thermometer & Inst. Co.	Philadelphia 30, Pa.
NN	Electra Manufacturing Co.	Kansas City, Mo.	BZ	Radio Essentials Inc.	Mt. Vernon, N. Y.
OO	Acro Manufacturing Co.	Columbus 16, Ohio	CA	Raytheon Manufacturing Co.	Newton, Mass.
PP	Alliance Manufacturing Co.	Alliance, Ohio	CB	Tung-Sol Lamp Works, Inc.	Newark 4, N. J.
QQ	Arco Electronics, Inc.	New York 13, N. Y.	CD	Varian Associates	Palo Alto, Calif.
RR	Astron Corp.	East Newark, N. J.	CE	Victory Engineering Corp.	Union, N. J.
SS	Axel Brothers Inc.	Long Island City, N. Y.	CF	Weckesser Co.	Chicago 30, Ill.
TT	Belden Manufacturing Co.	Chicago 44, Ill.	CG	Wilco Corporation	Indianapolis, Ind.
UU	Bird Electronics Corp.	Cleveland 14, Ohio	CH	Winchester Electronics, Inc.	Santa Monica, Calif.
VV	Barber Colman Co.	Rockford, Ill.	CI	Malco Tool & Die	Los Angeles 42, Calif.
WW	Bud Radio Inc.	Cleveland 3, Ohio	CJ	Oxford Electric Corp.	Chicago 15, Ill.
XX	Allen D. Cardwell Mfg. Co.	Plainville, Conn.	CK	Camloc-Fastener Corp.	Paramus, N. J.
YY	Cinema Engineering Co.	Burbank, Calif.	CL	George K. Garrett	Philadelphia 34, Pa.
ZZ	Any brand tube meeting RETMA standards.		CM	Union Switch & Signal	Swissvale, Pa.
AB	Corning Glass Works	Corning, N. Y.	CN	Radio Receptor	New York 11, N. Y.
AC	Dale Products, Inc.	Columbus, Neb.	CO	Automatic & Precision Mfg. Co.	Yonkers, N. Y.
AD	The Drake Mfg. Co.	Chicago 22, Ill.	CP	Bassick Co.	Bridgeport 2, Conn.
AE	Elco Corp.	Philadelphia 24, Pa.	CQ	Birnbach Radio Co.	New York 13, N. Y.
AF	Hugh H. Eby Co.	Philadelphia 44, Pa.	CR	Fischer Specialties	Cincinnati 6, Ohio
AG	Thomas A. Edison, Inc.	West Orange, N. J.	CS	Telefunken (c/o MYM, Inc.)	New York, N. Y.
AH	Fansteel Metallurgical Corp.	North Chicago, Ill.	CT	Potter-Brumfield Co.	Princeton, Ind.
AI	General Ceramics & Steatite Corp.	Keasbey, N. J.	CU	Cannon Electric Co.	Los Angeles, Calif.
AJ	The Gudeman Co.	Sunnyvale, Calif.	CV	Dynac, Inc.	Palo Alto, Calif.
			CW	Good-All Electric Mfg. Co.	Ogallala, Nebr.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. We will then advise you of the disposition to be made of the equipment and arrange for repair or replacement. Include model number and serial number when referring to this instrument for any reason.

WARRANTY

Hewlett-Packard Company warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to replace any defective parts thereof. Klystron tubes as well as other electron tubes, fuses and batteries are specifically excluded from any liability. This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

If any fault develops, the following steps should be taken:

1. Notify us, giving full details of the difficulty, and include the model number and serial number. On receipt of this information, we will give you service data or shipping instructions.
2. On receipt of shipping instructions, forward the instrument prepaid, to the factory or to the authorized repair station indicated on the instructions. If requested, an estimate of the charges will be made before the work begins provided the instrument is not covered by the warranty.

SHIPPING

All shipments of Hewlett-Packard instruments should be made via Truck or Railway Express. The instruments should be packed in a strong exterior container and surrounded by two or three inches of excelsior or similar shock-absorbing material.

DO NOT HESITATE TO CALL ON US

HEWLETT-PACKARD COMPANY

Laboratory Instruments / *for Speed and Accuracy*

275 PAGE MILL ROAD

CABLE



PALO ALTO, CALIF. U.S.A.

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